# INDOOR AIR QUALITY ASSESSMENT

**Abigail Adams Intermediate School**
**89 Middle Street**
**E. Weymouth, Massachusetts**

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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## Background/Introduction

At the request of a parent, the Massachusetts Department of Public Health (MDPH) Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at the Abigail Adams Intermediate School, Weymouth, MA. On October 10, 2001, a visit was made to the school by Cory Holmes, Environmental Analyst for BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) program, to conduct an assessment. Mr. Holmes was accompanied by Howard Leonard, Director of Maintenance, Weymouth School Department (WSD). Concerns about pigeon infestation of rooftop ventilation equipment during the previous school year prompted this request. Preliminary findings and recommendations concerning remediation efforts were previously outlined in a letter (MDPH, 2001).

The school is a three-story brick building constructed in 1974. The school contains general classrooms, health room, library, gymnasium, kitchen/cafeteria, several reading/resource rooms and offices. The building has hopper style windows that are openable.

## Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

## Results

The school houses grades pre-kindergarten through fifth grade. It has a student population of approximately 400 and a staff of approximately 80. Tests were taken during normal operations at the school and results appear in Tables 1-4.

## Discussion

### Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million parts of air (ppm) in seven out of thirty-four areas surveyed, indicating adequate ventilation in most areas of the school. The MDPH approach to resolving indoor air quality problems in school is generally two-fold: 1) improving ventilation to dilute and remove environmental pollutants and 2) reduce or eliminate exposure opportunities from materials that may be adversely affecting indoor air quality.

Fresh air in exterior classrooms is supplied by a unit ventilator (univent) system. Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building and return air through an air intake located at the base of each unit (see Figure 1). Fresh and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit. Interior classrooms, offices and common areas are ventilated by rooftop air handling units (AHUs), which are ducted to ceiling-mounted air diffusers and wall-mounted exhaust vents. Univents and AHUs were operable in all areas surveyed.

The mechanical exhaust ventilation system consists of wall-mounted exhaust vents or unit exhaust ventilators, which were operable in all areas surveyed. Wall-mounted exhaust vents in some classrooms are located approximately two to three feet above storage cabinets. Items were seen stored on top of these cabinets, blocking vents (see Picture 1). Care should be taken to avoid the blockage of these vents by items stored on top of these cabinets.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to

provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature measurements ranged from 70° F to 77° F, which were within the BEHA recommended comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building ranged from 31 to 36 percent, which was below the BEHA recommended comfort range. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

**Microbial/Moisture Concerns**

As previously outlined in a letter (MDPH, 2001), concerns regarding pigeon infestation prompted this assessment. Bird wastes in a building raise health concerns and warrant appropriate clean up/disinfection. Bird waste accumulated inside buildings is a public health concern since it can be a source of pathogens that may infect sensitive individuals. Fungi (molds) are associated with bird waste. While this particular mold has been found problematic with immune compromised patients, other diseases of the respiratory tract can result from exposure to bird waste. Exposure to bird wastes are thought to be associated with the development of hypersensitivity pneumonitis in some individuals. Psittacosis (bird fancier's disease) and histoplasmosis are diseases closely associated with exposure to bird wastes in either the occupational or bird raising settings. While immune compromised individuals have an increased risk of exposure to the materials in bird waste, the diseases

aforementioned may occur in healthy individuals exposed to these materials. At the time of the BEHA assessment pigeon wastes had been cleaned and screens were installed on rooftop exhaust motors to prevent bird egress. The BEHA bird waste recommendations letter is included as an Attachment.

Exterior walls of the building show signs of water intrusion. Water penetration through window frames was evident by the presence of a heavy coating of efflorescence (e.g. mineral deposits) and water-damaged plaster (see Picture 2). Efflorescence is a characteristic sign of water damage to building materials such as brick or plaster, but it is not mold growth. As moisture penetrates and works its way through mortar around brick, water-soluble compounds in bricks and mortar dissolve, creating a solution. As the solution moves to the surface of the brick or mortar, water evaporates, leaving behind white, powdery mineral deposits. According to school maintenance personnel, rainwater penetrates into the interior walls through flashing around window frames. Without proper flashing, water can readily penetrate through window frames. Reportedly the WSD is appropriating funding for window replacement.

Some classrooms had water-stained and/or missing ceiling tiles (see Picture 3), which is evidence of historic roof or plumbing leaks. Water-damaged ceiling tiles can provide a source of mold and mildew and should be replaced after a water leak is discovered. In addition, missing ceiling tiles can provide a pathway for the movement of odors, fumes, dusts and vapors into occupied areas.

**Other Concerns**

Several other conditions were noted during the assessment, which can affect indoor air quality. Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic

compounds (VOCs), (e.g. methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can also be irritating to the eyes, nose and throat.

Also of note was the amount of materials stored inside some classrooms. Items were seen piled on windowsills, tabletops, counters, bookcases and desks. The large amounts of items stored in classrooms provide a source for dusts to accumulate. These items (e.g. papers, folders, boxes, etc.) make it difficult for custodial staff to clean. Household dust can be irritating to eyes, nose and respiratory tract. Items should be relocated and/or cleaned periodically to avoid excessive dust build up.

## Conclusions/Recommendations

In view of the findings at the time of our inspection, the following recommendations are made to improve general indoor air quality:

1. Implement recommendations listed in previous BEHA correspondence (MDPH, 2001).
2. Continue with plans to repair/replace window systems to prevent further water damage and potential mold growth to building materials.
3. Consider having the systems re-balanced every five years by an HVAC engineering firm.
4. Remove obstructions from wall-mounted exhaust vents to facilitate airflow.
5. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended.

Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

6. Replace any remaining water-stained ceiling tiles. Examine the area above these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
7. Consider relocating/reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
8. Replace missing and/or broken ceiling tiles to prevent egress of dirt, dust and particulate matter into occupied areas.

## References

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL. Section M-308.1.1.

MDPH. 2001. Letter to Robert West, Superintendent, Weymouth Public Schools, regarding pigeon infestation of rooftop ventilation equipment at the Abigail Adams School, Weymouth, MA. Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, Boston, MA. December 2001.

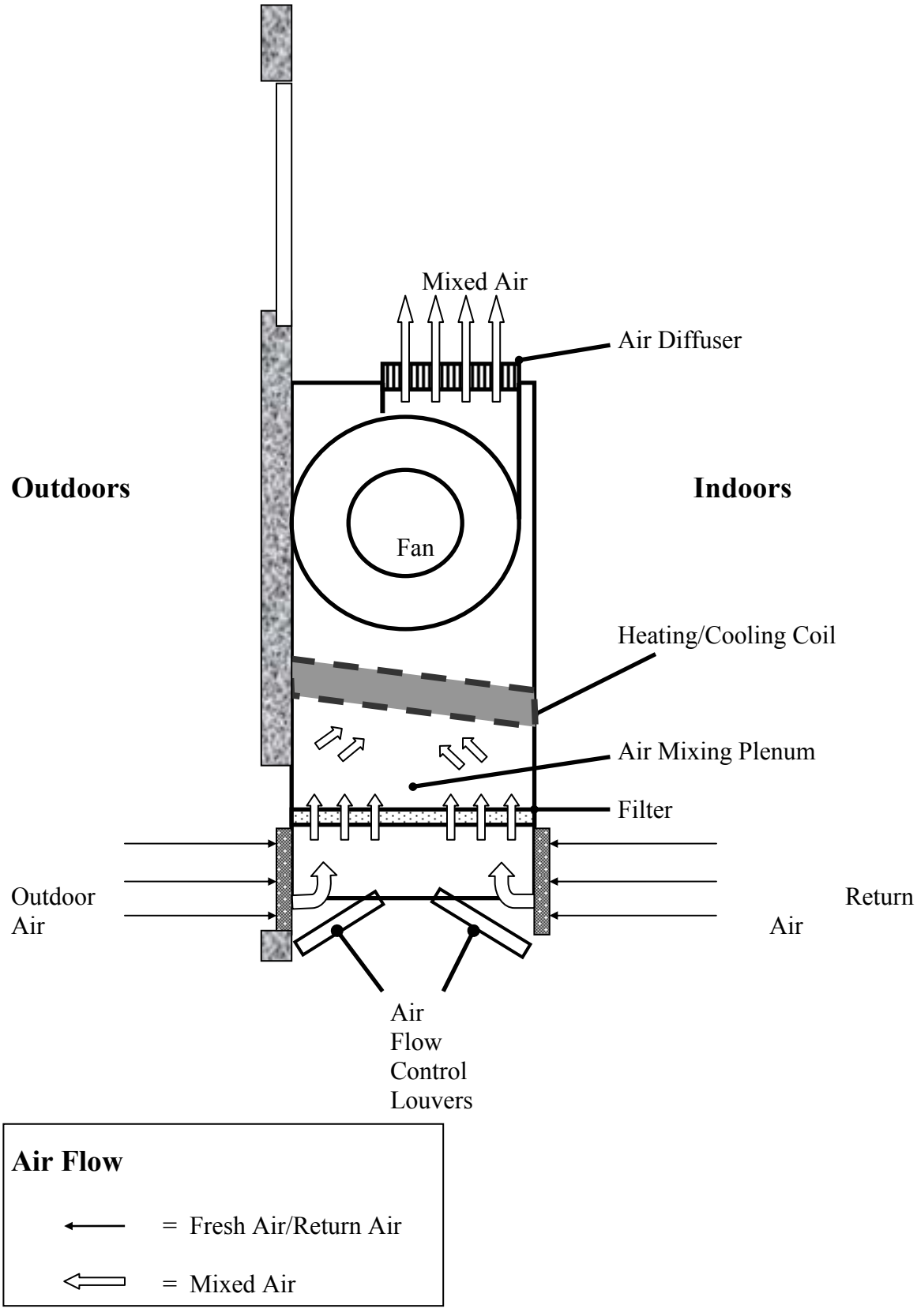
OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

Sanford. 1999. Material Safety Data Sheet (MSDS No: 198-17). Expo® Dry Erase Markers Bullet, Chisel, and Ultra Fine Tip. Sanford Corporation. Bellwood, IL.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

**Figure 1** **Unit Ventilator (Univent)**



**Picture 1**


**Partially Obstructed Exhaust Vent**

**Picture 2**

**Water Damage/Efflorescence around Window Frame**

**Picture 3**

**Water Stained/Missing Ceiling Tiles**

**TABLE 1**

## Indoor Air Test Results – Abigail Adams Intermediate School, Weymouth, MA – October 10, 2001

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| Outside (Background) | 373 | 65 | 40 | | | | | Weather conditions: clear, sunshine, light breeze |
| Rooftop notes | | | | | | | | Round vents – sealed out/in, #5– opening in screen, #11–"solid" Square vents – wired 4 sides, #28 – 1-1½" space, #18 – 2" space |
| Classroom 121 | 566 | 71 | 33 | 18 | No | Yes | Yes | 1 water damaged CT, door open |
| Room 122 (Teacher's Workroom) | 589 | 70 | 34 | 1 | Yes | Yes | Yes | Photocopier-odors, water damaged windowsills |
| Classroom 120B | 545 | 71 | 33 | 20 | No | Yes | Yes | 3 water damaged CT |
| Health Room | 576 | 73 | 33 | 3 | Yes | Yes | Yes | Efflorescence |
| Gym | 473 | 74 | 31 | 17 | No | Yes | Yes | |
| Classroom 103 | 474 | 73 | 31 | 20 | No | Yes | Yes | Water damaged CT |
| Classroom 104 | 522 | 73 | 31 | 15 | Yes | Yes | Yes | 3 water damaged CT, 3 missing CT |
| Classroom 102B | 565 | 73 | 31 | 9 | No | Yes | Yes | |

*** ppm = parts per million parts of air**
**CT = ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |

**TABLE 2**

## Indoor Air Test Results – Abigail Adams Intermediate School, Weymouth, MA – October 10, 2001

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| Classroom 108 | 867 | 75 | 35 | 24 | Yes | Yes | Yes | Window open |
| Classroom 119 | 588 | 74 | 31 | 20 | No | Yes | Yes | |
| Classroom 109 | 728 | 74 | 33 | 21 | Yes | Yes | Yes | Door open |
| Classroom 110 | 887 | 77 | 35 | 23 | Yes | Yes | Yes | Window open, univent/unit exhaust ventilator |
| Library | 606 | 75 | 30 | 20+ | No | Yes | Yes | Exacerbation of allergy symptoms |
| Classroom 111 | 821 | 76 | 33 | 26 | Yes | Yes | Yes | |
| Classroom 113 | 875 | 75 | 36 | 21 | Yes | Yes | Yes | |
| Classroom 209 | 860 | 75 | 33 | 22 | Yes | Yes | Yes | Door open |
| Classroom 212 | 857 | 73 | 32 | 22 | No | Yes | Yes | 1 water damaged CT |
| Classroom 213 | 703 | 73 | 31 | 1 | No | Yes | Yes | |
| Classroom 215B | 733 | 73 | 32 | 4 | Yes | Yes | Yes | |

*** ppm = parts per million parts of air**
**CT = ceiling tiles**

**Comfort Guidelines**

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

**TABLE 3**

## Indoor Air Test Results – Abigail Adams Intermediate School, Weymouth, MA – October 10, 2001

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| Classroom 218 | 952 | 73 | 34 | 27 | No | Yes | Yes | Door open |
| Classroom 217 | 696 | 74 | 33 | 25 | Yes | Yes | Yes | Kiln-vented outside |
| Classroom 221 | 705 | 74 | 33 | 22 | No | Yes | Yes | Air freshener taped to vent, door open |
| Classroom 223 | 762 | 74 | 33 | 23 | Yes | Yes | Yes | Window and door open, 1 water damaged CT-corner |
| Classroom 201 | 617 | 74 | 32 | 5 | Yes | Yes | Yes | |
| Classroom 203 | 542 | 78 | 31 | 8 | No | Yes | Yes | Noise-vibration from rooftop unit |
| Classroom 206 | 555 | 75 | 33 | 21 | Yes | Yes | Yes | Door open |
| Classroom 207 | 762 | 75 | 33 | 12 | No | Yes | Yes | |
| Classroom 001 | 574 | 73 | 31 | 24 | No | Yes | Yes | |
| Classroom 011 | 635 | 74 | 32 | 23 | Yes | Yes | Yes | Exhaust partially blocked |
| Classroom 010 | 766 | 74 | 33 | 22 | Yes | Yes | Yes | Window and door open |

*** ppm = parts per million parts of air**
**CT = ceiling tiles**

**Comfort Guidelines**

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

**TABLE 4**

## Indoor Air Test Results – Abigail Adams Intermediate School, Weymouth, MA – October 10, 2001

| Location | Carbon Dioxide *ppm | Temp. °F | Relative Humidity % | Occupants in Room | Windows Openable | Ventilation | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Intake | Exhaust | |
| Classroom 004 | 568 | 73 | 32 | 25 | No | Yes | Yes | |
| Classroom 007A | 792 | 74 | 33 | 24 | Yes | Yes | Yes | Subdivided-univent ducted into room from 007B |
| Classroom 007B | 518 | 74 | 32 | 1 | Yes | Yes | Yes | |
| Classroom 005 | 525 | 73 | 32 | 20 | No | Yes | Yes | |

*** ppm = parts per million parts of air**
**CT = ceiling tiles**

**Comfort Guidelines**

| | |
|---|---|
| Carbon Dioxide - | < 600 ppm = preferred |
| | 600 - 800 ppm = acceptable |
| | > 800 ppm = indicative of ventilation problems |
| Temperature - | 70 - 78 °F |
| Relative Humidity - | 40 - 60% |